



### **Technology to Make Silicon Crystals Promises Energy, Environmental Savings**

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Apr. 3--Before Intel can be inside, before cellular telephones can chirp, before solar cells can generate a watt, someone has to grow an incredibly precise silicon crystal, nearly 3 feet long and 8 inches in diameter, so perfect it looks like glass.

Growing those crystals is a multimillion dollar business in Clark County. Working in clean rooms, silicon, a chemical element found in the earth's crust, is heated in an oxygen-free furnace to temperatures twice as hot as the magma that spewed from Mount St. Helens. Then, carefully, in a process that takes just about a day, the crystal slowly is pulled from the crucible like cotton candy collects on a stick.

It takes more than skill and silicon, of course, to grow these crystals. It takes a lot of electricity, and a lot of argon, an expensive "greenhouse" gas that has environmental consequences if released.

That's where Greg Mihalik and Bryan Fickett come in. After a two-year, \$2 million experiment, they've made some major changes to the crystal-growing process, changes that could save the industry millions of dollars every year, while conserving electricity and reducing the use of argon.

"This project has been very, very successful," said Chet Farris, chief operating officer of Siemens Solar Industries, where Mihalik and Fickett work as engineers. "Every goal we set was met or exceeded."

Here's what's been accomplished so far:

- Power consumption has been reduced 51 percent
- Argon use has been reduced 85 percent, saving a considerable amount of money as well as reducing environmental risk.
- Production has increased 20 percent to 25 percent
- Crystal quality has improved, to the point where finished solar cells generate nearly 5 percent more electricity. That makes solar power 5 percent cheaper for the end customer.
- The project has stayed below its \$2 million budget, and the company has convinced at least one semiconductor company to try to replicate the results in that industry.

All of this accomplishment is a little strange. First, Siemens is a small crystal-growing operation, without any research labs or R&D engineers. And it's not even in the semiconductor industry,

because all of the Siemens crystals are made into photovoltaic cells, used to generate electricity from the sun.

Finally, the semiconductor industry is notoriously close-mouthed. Companies jealously guard their trade secrets, and it's unusual for an outsider to be allowed a glimpse of the production floor. SEH America Inc., the county's largest crystal-growing operation, even hides much of its large campus behind earthen berms, tall landscaping, and fencing.

Three years ago, none of this stopped Mihalik and Fickett, who'd been experimenting with adding insulation to the crystal-growing furnaces to cut down on energy consumption. Trouble was, the ingots that resulted were defective.

Through a third party, they heard about the Northwest Energy Efficiency Alliance, a nonprofit consortium funded by the region's electric utilities. The newly formed alliance had money to spend, and a mission to promote energy conservation among both consumers and industry.

For the energy alliance, funding R&D at a company devoted to making solar energy products was the perfect match. In 1998, the alliance and Siemens agreed to fund Mihalik's and Fickett's work, with each partner contributing \$1 million.

With the money, the engineers used computers to model how the inside of the furnace works as it heats silicon to 1,400 degrees Celsius, when it becomes molten. They looked at how the argon flowed through the material as it purged impurities.

After the data were in, they designed and tested a molybdenum shield that fits above the quartz crucible that holds the molten silicon. Because the shield keeps the crucible from being fully loaded, the engineers added a recharge hopper, so that silicon beads could be added to the mix as the crystal is pulled.

"There was a risk the technology wouldn't work, or that people wouldn't be interested," said Mihalik. So far, it's all turned out very well. The recharge system, in particular, has created some spectacular side benefits. Instead of making one ingot at a time, as many as 10 ingots can be pulled from a furnace without having to shut it down for cleaning. That saves time, increases output, and greatly saves argon and electricity.

The next step is to convince the semiconductor industry, which traditionally has eyed the photovoltaic people such as Siemens as little cousins with a crude technology.

"It's a very similar industry, although they have different grades of quality they manufacture," said Blair Collins, project manager for the energy efficiency alliance. Therefore, it's been tougher to get semiconductor companies' attention. On the other hand, because Siemens Solar isn't a direct competitor, it's allowed Mihalik and Fickett to be open about what they have accomplished and how they did it.

Siemens and the alliance invited all the local manufacturers to visit the project. On a skepticism scale of one to 10, most started at a seven or an eight, Collins said. After talks and tours, two companies, Wacker Siltronic Corp. and Mitsubishi Silicon America, have expressed some interest, and the alliance has reached an agreement to pay Wacker to try the recharge system itself. The experiment started last week.

"Our biggest interest is the energy savings and insulation concept," said Tom D'Silva, lead engineer for Wacker, which has its plant in northwest Portland. "They've done a lot of good work at Siemens. It's very relevant, I think, to the crystal-growing industry to have an energy secrecy project. I've always wondered over the years why we didn't develop the insulation."

So what's next? Mihalik and Fickett have published and presented a number of engineering papers, reporting on what they did and what the results were. They plan to do more of that, in hopes others will adopt some of their ideas. Siemens has applied for two patents on their work, and they hope the company can recoup, through the licensing fees, part of the \$1 million it staked them.

At Siemens, they've saved enough electricity to allow the plant to expand, if need be. Until now, it was maxed out on power. And there are more refinements in the works.

"We're not going back," said Mihalik.

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